FINAL REPORT

Pavement Design Report

Teston Road from Keele Street to Bathurst Street, Regional Municipality of York, Ontario

Submitted to:

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On Behalf of:
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Submitted by:

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Distribution List

1 eCopy - Morrison Hershfield

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1 INTRODUCTION

The Regional Municipality of York (Region) will be undertaking improvements to Teston Road between Keele Street and Bathurst Street as part of an Individual Environmental Assessment (IEA). The proposed improvements include realignment of Teston Road between Keele Street and about 500 m east of Keele Street, constructing a new segment of Teston Road from about 500 m east of Keele Street to Dufferin Street, and widening and rehabilitation of Teston Road between Dufferin Street and Bathurst Street.

WSP Canada Inc. (WSP) was retained by Morrison Hershfield (MH) to carry out the geotechnical/pavement investigations in support of the preliminary pavement designs for Teston Road within the project limits as described above.

This report should be read in conjunction with the “Important Information and Limitations of this Report” attached at the end of the report. The reader’s attention is specifically drawn to this information, as it is essential for the proper use and interpretation of this report.

The factual data, interpretations and recommendations contained in this report pertain to a specific project as described in the report and are not applicable to any other project or site location. If the project is modified in concept, location or elevation, or if the project is not initiated within two years of the date of the report, WSP should be given an opportunity to confirm that the recommendations are still valid.

2 PROJECT UNDERSTANDING

The existing road consists of two through lanes (one lane in each direction) throughout the project limits (with the exception of the missing link between 500 m east of Keele Street and Dufferin Street) with a continuous left lane and additional right turn lanes near intersections along the section of Teston Road between Dufferin and Bathurst. The proposed improvements include realignment, new alignment along the missing link, and widening to accommodate four through lanes (two in each direction), with additional left and right turn lanes near intersections and a centreline median of varying widths in some locations. Additionally, cycle tracks and boulevards will be constructed along both sides of the road. The purpose of the investigation was to evaluate the existing pavement structures as well as the subgrade and drainage conditions along Teston Road and the proposed alignments, and provide pavement design recommendations for the proposed new alignments, widening, as well as the rehabilitation of the existing lanes where applicable.

3 WORK PROGRAM

The geotechnical/pavement scope of work along Teston Road consisted of the following:

1) Visual pavement condition survey of Teston Road within the project limits to evaluate the existing condition of the pavement, in accordance with the Ontario Ministry of Transportation (MTO)’s Manual for Condition Rating of Flexible Pavements, SP-024;

2) Marking/staking all proposed borehole locations and arranging clearance of underground utilities at the proposed borehole locations;

3) Advancing boreholes to a depth of about 1.5 m below ground surface (mbgs) at selected locations along the new alignments and on the existing lanes, shoulders and boulevards/ditches;

4) Laboratory testing of selected representative samples of the granular base, subbase and subgrade soils to assess the material characteristics including grain size distribution, Atterberg Limits and water content; and

5) Pavement analysis and design and provision of a Preliminary Pavement Design Report.

4 INVESTIGATION PROCEDURE

The field work was carried out in January of 2023, at which time 36 boreholes were advanced to a depth of about 1.5 mbgs and 2 full depth hot-mix asphalt (HMA) cores were obtained from the locations shown on the Borehole/Core Location Plan (see Figure 1, attached). The boreholes were drilled using solid stem augers advanced by a truck mounted drill rig supplied and operated by a specialist drilling contractor, subcontracted to WSP. The off-road boreholes were advanced using hand augering equipment operated by WSP. The groundwater conditions were noted in the open boreholes during drilling. The soil samples obtained during the site investigation were brought to our Whitby laboratory where further examination and classification testing (i.e. water contents, grain size distributions and Atterberg Limits) were carried out on selected samples. At the two locations where full depth asphalt core samples were obtained, the boreholes could not be advanced due to utility conflicts.

The field work for this investigation was monitored on a full-time basis by members of WSP's engineering and technical staff, who logged the boreholes and cared for the recovered samples. The boreholes were advanced to identify and measure the individual pavement layers (HMA, granular base/subbase, etc.), assess the type of subgrade soils and groundwater conditions, and obtain material samples for laboratory testing.

It should be noted that the boundaries between the strata have been inferred from drilling observations and non continuous samples. They generally represent a transition from one soil type to another and should not be inferred to represent an exact plane of geological change. Furthermore, conditions will vary between and beyond the boreholes.

The information obtained from the boreholes and cores, and the results of laboratory testing carried out on selected samples are presented on the Record of Borehole Sheets in Appendix B.

5 SOIL AND PAVEMENT DATA

The following sections present the existing pavement condition based on the visual condition survey, pavement structure and subgrade soil conditions encountered in the boreholes, and the results of the laboratory testing carried out on selected samples of the granular base, subbase and subgrade soils.

5.1 Pavement Performance (Existing Condition)

In January 2023, WSP carried out a visual pavement condition inspection of Teston Road within the project limits. Teston Road was split into two sections due to differing surface conditions; Section 1 – Keele Street to 500 m east of Keele Street, and Section 2 – Dufferin Street to Bathurst Street. Section 1 is in poor condition, with a Pavement Condition Rating (PCR) of 45. Section 2 is in fairly good condition with a PCR of 75.

The majority of Teston Road within the project limits has a rural cross section with shoulders (partially paved and/or gravel shoulders) and ditches, and urban cross sections (curb and gutter) at intersections.

The following surface distresses were documented in Section 1:

- Frequent, slight ravelling;
- Intermittent, moderate potholes;
- Frequent, slight pavement edge breaks;
- Extensive, moderate wheel track rutting;
- Intermittent, moderate distortions;
- Intermittent, slight utility trench patches
- Frequent, moderate longitudinal cracking;
- Frequent, moderate transverse cracking;
- Frequent, moderate pavement edge cracking;
- Frequent, slight map cracking; and
- Frequent, moderate alligator cracking.

The Ride Condition Rating (RCR) is 4 in Section 1.

The following surface distresses were documented in Section 2:

- Frequent, slight ravelling;
- Intermittent, slight potholes;
- Intermittent, slight pavement edge breaks;
- Frequent, slight wheel track rutting;
- Intermittent, slight distortions;
- Intermittent, slight utility trench patches
- Intermittent, moderate longitudinal cracking;
- Intermittent, moderate transverse cracking;

- Intermittent, slight pavement edge cracking;
- Intermittent, slight map cracking; and
- Intermittent, slight alligator cracking.

The RCR is 7 in Section 2.

Details of the pavement condition surveys are included in Appendix A.

5.2 Pavement Structure

The existing pavement structures encountered in the lanes in various sections of Teston Road are summarized in Table 1. The pavement structures encountered in the shoulders along Teston Road are summarized in Table 2.

Table 1: Summary of Existing Pavement Structures on Teston Road Lanes

Section	Pavement Component	Pavement Thickness on Mainlanes	
		Range (mm)	Average (mm)
Teston Road*, West of Keele Street	HMA	145	145
	Granular Base	650	650
	Granular Subbase**	700	700
	Total Pavement Thickness	1500	1500
Teston Road*, East of Keele Street	HMA	200	200
	Granular Base	270	270
	Granular Subbase	300	300
	Total Pavement Thickness	770	770
Teston Road, Dufferin Street to Bathurst Street	HMA	155 - 260	185
	Granular Base	220 - 300	260
	Granular Subbase	350 - 580	440
	Total Pavement Thickness	840 - 1000	880

*Based on one borehole; **Granular subbase material extended to the borehole termination depth - likely trench fill material.

Table 2: Summary of Existing Pavement Structures on Teston Road Shoulders

Section	Pavement Component	Pavement Thickness on Shoulders	
		Range (mm)	Average (mm)
Teston Road*, East of Keele Street	Granular Base	520	520
	Granular Subbase	380	380
	Total Pavement Thickness	900	900
Teston Road, Dufferin Street to Bathurst Street	HMA	160 - 200	170
	Granular Base	210 - 310	250
	Granular Subbase**	380 - 560	460
	Total Pavement Thickness	840 - 960	880

*Based on one borehole; **In one BH (BH-P16), the granular subbase extended to the borehole termination depth (likely trench fill material) – thickness not included in the statistical calculations.

Gradation testing was carried out on six (6) granular base samples. The results indicated that none of the samples tested satisfied the current OPSS.PROV 1010 gradation requirements for Granular A. In most cases, the samples were too fine on most of the sieve sizes, as shown on Figure C1 in Appendix C. The water content of the granular base samples ranged from 3 to 8 percent.

Gradation testing was carried out on six (6) granular subbase samples. None of the granular subbase samples satisfied the current OPSS.PROV 1010 gradation requirements for Granular B, Type I, generally due to excessive material passing the 75 µm sieve, as shown on Figure C2 in Appendix C. The water content of the subbase samples tested ranged from 2 to 7 percent.

5.3 Subgrade Soils

The predominant subgrade soil types encountered in the boreholes (both native and fill materials) included silty clay/clayey silt, with silty sand, sand with varying amounts of gravel and silt, and sandy silt encountered in some locations.

Laboratory testing was carried out on selected samples of the subgrade materials. The subgrade soils were generally in a moist condition, with two samples in a wet condition encountered in the ditch boreholes. The in-situ water contents of the silty clay/clayey silt subgrade materials generally were 15 percent, and the moisture content of the silty sand, sand and sandy silt materials was 8 to 21 percent. The results of particle size distribution testing carried out on the subgrade soil samples are shown on Figures C3 – C5, in Appendix C.

5.3.1 Frost Susceptibility

The frost susceptibility of the subgrade soils has been assessed using the Ministry of Transportation of Ontario's ("MTO") guidelines, which are based on the percentage of silt particles coarser than 5 µm, as outlined in Table 3.

Table 3: MTO Frost Susceptibility Guidelines

Grain Size (75 – 5 µm)	Susceptibility to Frost Heaving
0 – 40 %	Low
40 – 55 %	Moderate
55 – 100 %	High

The subgrade soils tested generally had low susceptibility to frost heave.

5.4 Groundwater

The boreholes advanced to a depth of 1.5 m were dry upon completion of drilling. It is expected that the groundwater levels will fluctuate, being higher during wet periods (i.e. spring thaw) and lower during the drier, summer periods.

6 PAVEMENT DESIGN AND ANALYSIS

This section of the report provides engineering information for the geotechnical/pavement design aspects of the project, based on our interpretation of the information obtained during this investigation, and our understanding of the project requirements. The information in this portion of the report is provided for the guidance of the design engineers. Where comments are made on construction, they are provided only in order to highlight aspects of construction which could affect the design of the project. Contractors bidding on or undertaking any work at the site should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction and make their own interpretation of the factual data as it affects their proposed construction techniques, schedule, equipment capabilities, costs, sequencing and the like.

6.1 Traffic Data

The traffic data for Teston Road provided by MH in an email dated February 21, 2023, is summarized in Table 4.

Table 4: Traffic Data

Design Feature	Parameters
2- way AADT (year) Teston Road from Keele Street to Dufferin Street	27,790 (2041)
2-way AADT (year) Teston Road from Dufferin Street to Bathurst Street	23,350 (2041)
% Commercial Vehicles	6%
Annual Traffic Growth Rate	2.2%

6.2 AASHTO Design Analysis

The designs for the realignment, widening and rehabilitation of the pavements within the project limits have been developed using the “1993 AASHTO Guide for the Design of Pavement Structures”. Traffic load calculations have been carried out in accordance with MTO’s “Procedures for Estimating Traffic Loads for Pavement Design, 1995”. AASHTO pavement design parameters have been selected from MTO’s Materials Information Report, MI-183 “Adaptation and Verification of AASHTO Pavement Design Parameters for Ontario Conditions”, dated March 19, 2008 (MI-183).

Based on the Region’s road classification system, and the AADT data above, this section of Teston Road is considered to be a Major Arterial Road. The estimation of the Equivalent Single Axle Loads (ESALs) has been carried out over a design period of 15 years for the pavement rehabilitation portion and 20 years for the realignment, new construction and widening portions, using the traffic data as well as the breakdown for commercial traffic listed in MI-183. For the realignment/reconstruction and new construction segments of Teston Road between Keele Street and Dufferin Street, the estimated ESALs over a 20-year design life are about 11,700,000. For the pavement rehabilitation component between Dufferin Street and Bathurst Street, the estimated ESALs over a 15-year design life are about 7,000,000. For the widening component between Dufferin Street and Bathurst Street, the estimated ESALs over a 20-year design life are about 9,800,000. It has been assumed that construction will be completed in 2041.

We understand that the minimum standard design used for Arterial Roads in the Region is as follows:

- 50 mm SP 12.5
- 100 mm SP 19.0
- 150 mm Granular A
- Minimum 450 mm Granular B

Minimum pavement thickness = 750 mm

Structural Number (SN) = 124 mm

The results of the AASHTO Pavement Design analysis will be compared to the Region's minimum pavement design standards shown above, and the more conservative design will be used.

The results of the borehole investigation and laboratory testing were used to develop the pavement designs and the rehabilitation strategies.

The resilient modulus of the subgrade soil was estimated based on the in-situ water content of the soils encountered in the boreholes, and the results of laboratory classification testing of the subgrade soils. Although silty sand, sand and sandy silt was encountered in some of the boreholes, the predominant native subgrade soils within the project limits is silty clay/clayey silt. Based on Table 8-6 of MI-183 "Adaptation and Verification of the AASHTO Pavement Design for Ontario Conditions" dated March 19, 2008, the recommended resilient modulus values for silty clay/clayey silt soils (the predominant soil type within the project limits) ranges between 15 MPa and 35 MPa. A resilient modulus of 30 MPa and 25 MPa was selected for the design analysis for the rehabilitation and widening designs for Teston Road (between Dufferin Street and Bathurst Street), respectively. A higher value was used for the resilient modulus of the soil under the existing lanes, as the subgrade soil has been in place for several years with repeated traffic loading, and thus has a lower moisture content and higher strength when compared to the same soil type in the ditches/boulevards. For the new construction/realignment pavement design between Keele Street and Dufferin Street, a resilient modulus of 30 MPa was used as the realignment is largely over an existing alignment, and the new construction will generally be built on an embankment.

6.2.1 Design Parameter

The 1993 AASHTO Guide for Design of Pavement Structures (AASHTO) was used to design the pavement reconstruction/new construction, rehabilitation and widening strategies for Teston Road. In accordance with MI-183, the design parameters used for the pavement design analysis are summarized in Table 5.

Table 5: Pavement Design Parameters

Design Criteria	Parameters Selected – Major Mackenzie Drive
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level (%)	90 (rehabilitation) 95 (new construction and widening)
Overall Standard Deviation	0.47
Roadbed Soil Resilient Modulus	30 MPa (Rehabilitation and New Construction) 25 MPa (Widening areas)

6.2.2 Structural Numbers

The structural and drainage coefficients selected for the existing and new pavement materials are listed in Table 6.

Table 6: Structural and Drainage Coefficients

Material	Structural Coefficient	Drainage Coefficient
Existing HMA	0.28	1.0
Existing Granular Base	0.12	0.8
Existing Granular Subbase	0.09	0.8
New HMA	0.42	1.0
New Granular 'A' Base	0.14	1.0
New Granular 'B Type I' Subbase	0.09	1.0

The existing and required Structural Numbers (SN), as well as the calculated structural deficiency based on the analysis, are listed in Table 7 below.

Table 7: Structural Numbers

Section	Existing SN (mm)	Required SN (mm)	Structural Deficiency (mm)
Keele Street to Dufferin Street Realignment/ New Construction	-	155	155
Dufferin Street to Bathurst Street Rehabilitation	109	137	28
Dufferin Street to Bathurst Street Widening	-	160	160

7 RECOMMENDED PAVEMENT DESIGNS

7.1 Pavement Reconstruction/New Construction – Keele Street to Dufferin Street

The recommended pavement design for the realignment/reconstruction and new construction of Teston Road between Keele Street and Dufferin Street is presented below. The prepared subgrade should be proof rolled, inspected and approved by a Geotechnical representative before placement of the granular subbase materials.

Excavate the footprint of the proposed roadway to a depth of 980 mm below the proposed finished pavement surface, or place approved fill materials to 980 mm below proposed finished pavement surface, and place the following:

- 50 mm SP 12.5 FC1, Surface Course
- 50 mm SP 19.0, Upper Binder Course

- 80 mm SP 25.0, Lower Binder Course
- 200 mm new Granular ‘A’ Base compacted to 100% of the material’s Standard Proctor Maximum Dry Density (SPMDD); and
- 600 mm new Granular ‘B’ Type I Subbase in lifts not exceeding 300 mm and compacted to 100% of the material’s SPMDD.

7.2 Pavement Rehabilitation – 100 m West of Dufferin Street to Bathurst Street

The recommended pavement rehabilitation strategy for Teston Road between 100 m west of Dufferin Street and Bathurst Street is as follows:

Mill 110 mm of the existing HMA, and place 150 mm of new HMA as follows:

- 50 mm SP 12.5 FC1, Surface Course
- 50 mm SP 19.0, Upper Binder Course
- 50 mm SP 19.0, Lower Binder Course

This rehabilitation strategy will result in a 40 mm grade raise.

7.3 Pavement Widening – 100 m West of Dufferin Street to Bathurst Street

The recommended pavement design for the widening of the roadway is presented below. The prepared subgrade should be proof rolled, inspected and approved by a Geotechnical representative before placement of the granular subbase materials. In order to provide adequate lateral drainage for the existing pavements, the bottom of the granular subbase thickness in the widening areas should match or exceed the bottom of the granular subbase in the adjacent existing pavement.

Excavate the widening area beyond the existing edge of pavement to a minimum depth of 980 mm below the proposed finished pavement grade, and place the following:

- 50 mm SP 12.5 FC1, Surface Course
- 50 mm SP 19.0, Upper Binder Course
- 80 mm SP 25.0, Lower Binder Course
- 250 mm new Granular ‘A’ Base compacted to 100% of the material’s SPMDD; and
- 550 mm new Granular ‘B’ Type I Subbase in lifts not exceeding 300 mm and compacted to 100% of the material’s SPMDD.

7.4 Bridge Decks – Teston Road West of Dufferin Street

The pavement structure on the bridge decks should be as follows:

40 mm	SP 12.5 FC1	Surface Course
40 mm	SP 12.5 FC1	Binder Course
Over waterproofing		

The recommended pavement structure over the concrete approach slabs is as follows:

40 mm	SP 12.5 FC1	Surface Course
50 mm	SP 19	Binder Course

8 TRANSITION DETAILS

At the east limit of the project where the rehabilitated/widened Teston Road ties into existing, the tie-in should be constructed as follows:

- Remove the existing HMA on Teston Road to a depth of 0 - 40 mm over a distance of 10 m, starting at 0 at the project limits to a 40 mm milling depth at 10 m beyond the project limits and pave:

40 mm	SP 12.5 FC1	Surface Course

Where the realigned/reconstructed Teston Road ties into Keele Street at the north and south limits, a stepped joint should be constructed as follows:

- Mill 50 mm of the existing HMA on Keele Street over a distance of 1 m and pave:

50 mm	SP 12.5 FC1	Surface Course

9 TOPSOIL

Topsoil encountered in the boreholes ranged in thickness from 50 mm to 200 mm. For estimating purposes, an average topsoil thickness of 150 mm can be used.

10 DRAINAGE

Ditching will be required in cuts within rural cross sections. As a minimum, the invert of the ditches should be 0.5 m below the bottom of the adjacent granular base layer. To facilitate drainage, the granular base materials should extend across the full-width of the roadway and daylight into the ditches.

In areas where an urban cross section is proposed, a proper drainage system should be installed along the new EP immediately below the proposed subgrade elevation. The drainage system should consist of a 150 mm diameter perforated pipe, placed inside a 300 mm by 300 mm trench and surrounded by clear stone. The trench should be lined with a suitable geotextile prior to placing the clear stone. At the top of the trench, the geotextile should overlap a minimum of 300 mm. The geotextile should conform to OPSS 1860, Class II and be nonwoven with a F.O.S. in the range of 75 to 150 micron. The subdrain invert should be approximately 250 mm below the bottom of the granular base.

The bottom of the granular subbase layer in the widened areas should match or exceed the bottom of the granular base/subbase layer of the existing adjacent lane or shoulder, to facilitate lateral drainage. The granular subbase thickness in the widening areas will have to be increased if highly frost susceptible soils, soft/wet soils, or organics are encountered. As such, the exposed subgrade soils in the widening areas should be inspected by a qualified geotechnical engineer before placing the granular materials.

11 FROST PENETRATION DEPTH

A frost penetration depth of 1.4 m can be assumed for design purposes.

12 ASPHALT CEMENT

It is recommended that PG 64-28 asphalt cement be used in all the HMA layers on this project. The asphalt cement quality should satisfy the Region's technical specifications.

13 TRAFFIC CATEGORY

The Superpave asphalt mix designs should be designed for Category D, based on the 20-year Design ESALs of 11,700,000.

14 TACK COAT

It is recommended that tack coat be applied between all new lifts of HMA and on all milled surfaces. Tack coat should conform to the requirements of Ontario Provincial Standard Specification OPSS.PROV 308 (April 2012).

15 COMPACTION

The granular base and subbase materials should be compacted to 100 percent of the material's SPMDD. The SP 12.5 FC1 surface course asphalt should be compacted to a minimum of 92% of the material's Maximum Relative Density (MRD) while the SP 19 and SP 25 binder course mixes should be compacted to a minimum of 91% of the MRD. Joint compaction for the SP 12.5 FC1, SP 19 and SP 25 mixes should be a minimum of 90%.

16 INSPECTION AND TESTING

During construction, in-situ density tests and materials testing should be carried out to confirm that the conditions exposed are consistent with those encountered in the boreholes and to monitor conformance to the pertinent project specifications. Asphalt testing should be carried out in a CCIL certified laboratory.

17 CLOSURE

We trust that this report provides sufficient pavement engineering information to proceed with the design of this project. If you have any questions regarding the contents of this report or require additional information, please do not hesitate to contact this office.

Signature Page

WSP Canada Inc.

Karolina Konarski, M.A.Sc. P.Eng.
Senior Pavement and Materials Engineer

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IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: WSP Canada Inc. (WSP) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to WSP by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. WSP cannot be responsible for use of this report, or portions thereof, unless WSP is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without WSP's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, WSP may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to WSP. The report, all plans, data, drawings and other documents as well as all electronic media prepared by WSP are considered its professional work product and shall remain the copyright property of WSP, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of WSP. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client can not rely upon the electronic media versions of WSP's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to WSP by the Client, communications between WSP and the Client, and to any other reports prepared by WSP for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. WSP can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Ground Water Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, WSP does not warrant or guarantee the exactness of the descriptions.

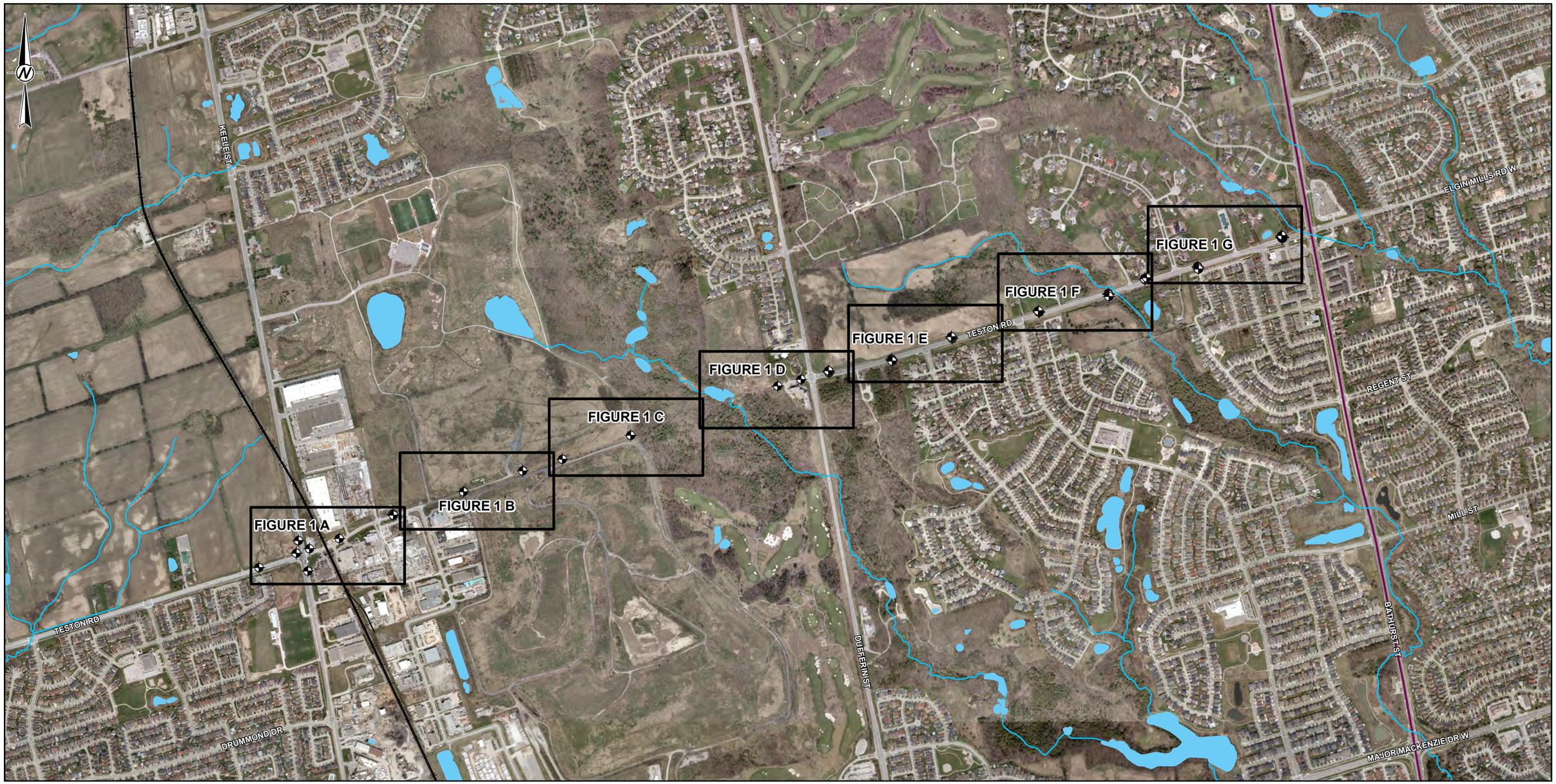
Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that WSP interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: WSP will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client’s expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of WSP's report. WSP should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of WSP's report.

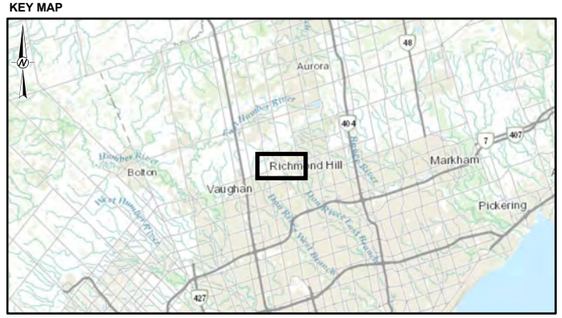
During construction, WSP should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of WSP's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in WSP's report. Adequate field review, observation and testing during construction are necessary for WSP to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, WSP's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.



LEGEND

- BOREHOLE LOCATION
- COREHOLE LOCATION
- RAILWAY
- WATER BODY
- WATERCOURSE

KEY MAP



SCALE: 1:750,000

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NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ONTARIO
2. BASE MAP: © THE REGIONAL MUNICIPALITY OF YORK, CITY OF BRAMPTON, CITY OF TORONTO, YORK REGION, ONTARIO BASE MAP, PROVINCE OF ONTARIO, ONTARIO MNR, ESRI CANADA, ESRI, © OPENSTREETMAP CONTRIBUTORS, HERE, GARMIN, USGS, NGA, EPA, USDA, NPS, AAFC, NRCAN
3. COORDINATE SYSTEM: NAD 1983 CSRS UTM ZONE 17N

CLIENT
MORRISON HERSHFIELD

PROJECT
IEA TESTON ROAD AREA (Y.R. 49) BETWEEN HIGHWAY 400 AND BATHURST STREET (Y.R. 38) IN THE CITY OF VAUGHAN

TITLE
BOREHOLE/CORE LOCATION PLAN

CONSULTANT
wsp

YYYY-MM-DD	2023-03-13
DESIGNED	----
PREPARED	JT
REVIEWED	TD
APPROVED	----

PROJECT NO.	CONTROL	REV.	FIGURE
21496759	0001	A	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

0 25mm

PATH: S:\Clients\MTO\Teston_Rd\99_PROJ\21496759\40_PROD\0001_Pavements\21496759-0001-BG.aprx PRINTED ON: AT: 11:32:18 AM

LEGEND

- BOREHOLE LOCATION
- RAILWAY

KEY MAP

SCALE: 1:50,000

0 15 30 60

1:1,500 METRES

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

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PROJECT NO.	CONTROL	REV.	FIGURE
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PATH: S:\Clients\MTO\Teston_Rd\99_PROJ\21496759\40_PROD\0001_Pavements\21496759-0001-BG.aprx PRINTED ON: AT: 11:34:41 AM
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
25mm
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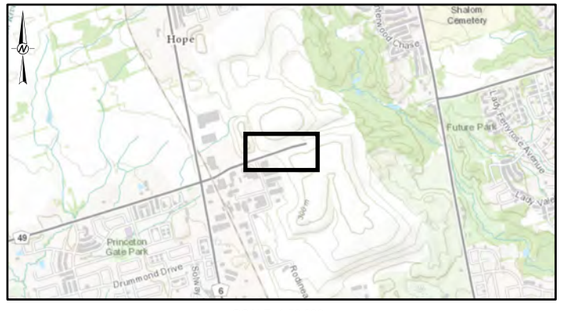
LEGEND

BOREHOLE LOCATION

KEY MAP



SCALE: 1:50,000

0 15 30 60

1:1,500 METRES

NOTE(S)

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REFERENCE(S)

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APPROVED	----

PROJECT NO.	CONTROL	REV.	FIGURE
21496759	0001	A	1 B

PATH: S:\Clients\MTO\Teston_Rd\99_PROJ\21496759\40_PROD\0001_Pavements\21496759-0001-BG.aprx PRINTED ON: AT: 11:35:14 AM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

0 25mm

LEGEND

BOREHOLE LOCATION

KEY MAP

SCALE: 1:50,000

0 15 30 60

1:1,500 METRES

NOTE(S)

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REFERENCE(S)

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APPROVED	----

PROJECT NO.	CONTROL	REV.	FIGURE
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PATH: S:\Clients\MTO\Teston_Rd\9b_PRO\21496759\40_PRO\0001_Pavements\21496759-0001-BG.aprx PRINTED ON: AT: 11:35:47 AM
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
0 25mm

LEGEND

BOREHOLE LOCATION

KEY MAP

SCALE: 1:50,000

0 15 30 60

1:1,500 METRES

NOTE(S)

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REFERENCE(S)

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TITLE
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wsp

YYYY-MM-DD	2023-03-13
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REVIEWED	TD
APPROVED	----

PROJECT NO.	CONTROL	REV.	FIGURE
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PATH: S:\Clients\MTO\Teston_Rd\99_PROJ\21496759\40_PROD\0001_Pavements\21496759-0001-BG.aprx PRINTED ON: AT: 11:36:20 AM

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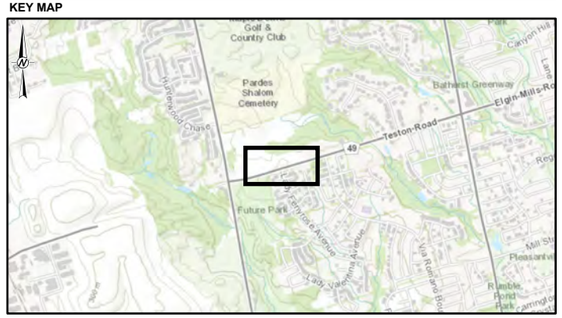
0 25mm

LEGEND

BOREHOLE LOCATION

KEY MAP



SCALE: 1:50,000

0 15 30 60

1:1,500 METRES

NOTE(S)

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3. COORDINATE SYSTEM: NAD 1983 CSRS UTM ZONE 17N

CLIENT
MORRISON HERSHFIELD

PROJECT
IEA TESTON ROAD AREA (Y.R. 49) BETWEEN HIGHWAY 400 AND BATHURST STREET (Y.R. 38) IN THE CITY OF VAUGHAN

TITLE
BOREHOLE/CORE LOCATION PLAN

CONSULTANT

YYYY-MM-DD	2023-03-13
DESIGNED	----
PREPARED	JT
REVIEWED	TD
APPROVED	----

PROJECT NO.	CONTROL	REV.	FIGURE
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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

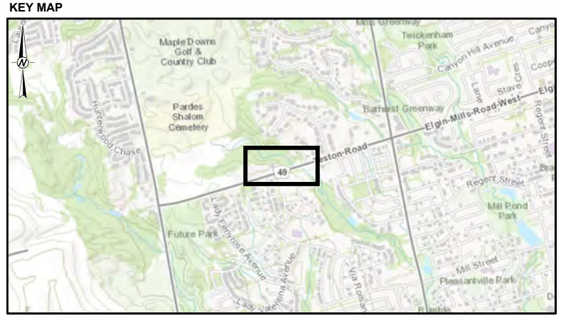
25mm

0

LEGEND

BOREHOLE LOCATION

KEY MAP



SCALE: 1:50,000

0 15 30 60

1:1,500 METRES

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PROJECT NO.	CONTROL	REV.	FIGURE
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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

0

LEGEND

- BOREHOLE LOCATION
- COREHOLE LOCATION

KEY MAP

SCALE: 1:50,000

0 15 30 60

1:1,500 METRES

NOTE(S)

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CLIENT
MORRISON HERSHFIELD

PROJECT
IEA TESTON ROAD AREA (Y.R. 49) BETWEEN HIGHWAY 400 AND BATHURST STREET (Y.R. 38) IN THE CITY OF VAUGHAN

TITLE
BOREHOLE/CORE LOCATION PLAN

CONSULTANT

wsp

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PREPARED	JT
REVIEWED	TD
APPROVED	----

PROJECT NO.	CONTROL	REV.	FIGURE
21496759	0001	A	1 G

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0 25mm

APPENDIX A

Pavement Condition Survey Forms

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Teston Road **Location From** Keele Street **To** Landfill

Section Length 0.5 (KM) **Survey Date** January 16, 2023 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. **Work Project No.** **Class** M (F: Freeway, C: Connecting Link, A: Major Artierial, M: Minor Artierial, R: Residential)

Pavement Condition Rating (PCR) 45 **Riding Condition Rating (RCR)** 4 **Evaluated by** TSD

Riding Condition Rating (At Posted Speed)

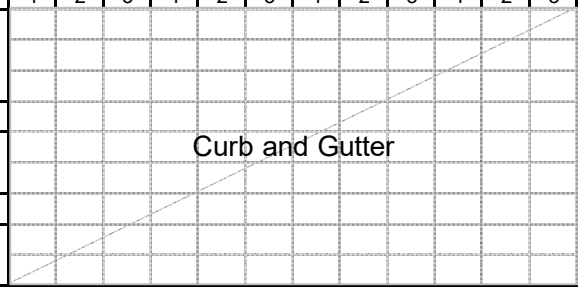
10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20, 1)	Frequent (20-50, 2)	Extensive (>50, 3)
Surface Defects	Ravelling	1	x				x	
	Flushing	2						
	Potholes	3		x		x		
	Pavement Edge Breaks	4	x				x	
	Manholes and Catchbasins	5		x			x	
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7		x				x
	Distortion	8		x		x		
	Utility Trenches	9	x			x		
Cracking	Longitudinal	10		x			x	
	Transverse	11		x			x	
	Pavement Edge	12		x			x	
	Map	13	x				x	
	Alligator	14		x			x	

Distress Comments (Items not covered above)

Recommendation by Evaluator

Shoulder Distress Manifestation			Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Dominant Type	one	Distress												
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial		Cracking												
		Breakup and Potholes												
Surface Treated														
		Distortion												
Primed		Pavement Edge Curb Sepatation												



Maitenance Treatment								
Pavement	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)
Manual Patching	X			Manual patching			
Machine Patching				Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal							

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Teston Road **Location From** Dufferin Road **To** Bathurst Street

Section Length 2.0 (KM) **Survey Date** January 16, 2023 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. **Work Project No.** **Class** A (F: Freeway, C: Connecting Link, A: Major Artierial, M: Minor Artierial, R: Residential)

Pavement Condition Rating (PCR) 75 **Riding Condition Rating (RCR)** 7 **Evaluated by** TSD

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (<20, 1)	Frequent (20-50, 2)	Extensive (>50, 3)
Surface Defects	Ravelling	1	x				x	
	Flushing	2						
	Potholes	3	x			x		
	Pavement Edge Breaks	4	x			x		
	Manholes and Catchbasins	5	x			x		
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7	x				x	
	Distortion	8	x			x		
	Utility Trenches	9	x			x		
Cracking	Longitudinal	10		x		x		
	Transverse	11		x		x		
	Pavement Edge	12	x			x		
	Map	13	x			x		
	Alligator	14	x			x		

Distress Comments (Items not covered above)

Recommendation by Evaluator

Shoulder Distress Manifestation			Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Dominant Type	one	Distress												
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial		Cracking												
		Breakup and Potholes												
Surface Treated														
		Distortion												
Primed		Pavement Edge Curb Sepatation												

Curb and Gutter

Maitenance Treatment								
Pavement	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence %: <20 (1)	20-50 (2)	>50 (3)
Manual Patching	X			Manual patching			
Machine Patching	X			Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal							

APPENDIX B

Record of Borehole Logs

TABLE 1
RECORD OF BOREHOLE LOGS
Pavement Investigation

BOREHOLE NO.	Station No.	BOREHOLE LOG Depth (mm)			Description	Sample Depth (mm)			Water Content (%)	K-Factor	LABORATORY TESTING Frost Susceptibility	Comments
Keele Street												
Location		5.7 m Lt of C/L, SBL										
BH-P1	2+250	0	-	280	Asph							
		280	-	640	Br Cr Gran	300	-	600	2.9			Unacceptable OPSS 1010 Granular A (most sieve sizes too fine)
		640	-	1.5	Dk Br Si Cl Tr Sa Tr Gr, Moist							
Location		8.9 m Rt of C/L, NB RTL										
BH-P3	2+120	0	-	230	Asph							
		230	-	400	Br Cr Gran							
		400	-	950	Br F Sa W Gr Tr Si, Moist	650	-	950	6.5			Unacceptable OPSS 1010 Granular B Type I (due to excessive fines)
		950	-	1.5	Br Si Cl Tr Sa Tr Gr, Moist							
Teston Road												
Location		1.6 m Lt of C/L, WB L1										
BH-P2	1+100	0	-	145	Asph							
		145	-	800	Br Cr Gran	200	-	500	2.6			Unacceptable OPSS 1010 Granular A (most sieve sizes too fine)
		800	-	1.5	Br F Sa W Gr Tr Si, Moist							
Location		12.5 m Lt of C/L, WB Blvd										
BH-P6	1+250	0	-	75	Dk Br Tps							
		75	-	300	Br F Sa Tr Si, Moist							
			-	300	NFP Utility Conflict							
Location		21.2 m Lt of C/L, WB Blvd										
BH-P4	1+305	0	-	160	Dk Br Tps							
		160	-	1.5	Br Cl Si Tr Sa Tr Gr, Moist							
Location		7.2 m Lt of C/L, WB Shld										
BH-P5	1+425	0	-	460	Br Sa W Gr Tr Si, Moist							
		460	-	1.5	Br Si Cl W Sa Tr Gr, Moist	1.2	-	1.5	14.5	0.4	LSFH	CL-ML (LL=20, PL=13, PI=7)
Location		3.5 m Lt of C/L, WB Shld										
BH-P7	1+650	0	-	520	Br Cr Gran							
		520	-	900	Br Sa W Gr Tr Si, Moist							
		900	-	1.5	Dk Br Si Cl Tr Sa Tr Gr, Moist							
Location		1.7 m Lt of C/L, WBL										
BH-P8	1+650	0	-	200	Asph							
		200	-	470	Br Cr Gran							
		470	-	770	Br Sa W Gr Tr Si, Moist	470	-	770	3.4			Unacceptable OPSS 1010 Granular B Type I (due to excessive fines)
		770	-	1.5	Dk Br Si Cl Tr Sa Tr Gr, Moist							
Location		Fut. C/L, Access Road to Landfill										
BH-P9	1+950	0	-	160	Dk Br Sa W Gr, Moist							
		160	-	600	Br Cr Gran							
		600	-	1.5	Br Gr(y) Sa Tr Si, Moist							
Location		Fut. C/L, Landfill										
BH-P10	2+200	0	-	150	Dk Br Tps							
		150	-	640	Br Si Sa So Cl Tr Gr, Moist	300	-	600	7.5	0.2	LSFH	
		640	-	1.5	Br F Sa Tr Si Tr Gr, Moist							
Location		Fut. C/L, Landfill										
BH-P11	2+320	0	-	170	Dk Br Tps							
		170	-	1.5	Br Sa Tr Si Tr Gr, Moist							
Location		Fut. C/L, Landfill										
BH-P12	2+635	0	-	200	Dk Br Tps							
		200	-	550	Br Sa W Gr Tr Si, Moist							
		550	-	1.5	Br Sa Si So Cl Tr Gr, Moist	700	-	1.0	10.3	0.35	LSFH	
Location		Fut. C/L Access Road to TACC Site										
BH-P13	3+240	0	-	1.5	Br Gr(y) Sa, Tr Si, Moist							
Location		5.2 m Rt of C/L, EBL										
BH-P14	3+335	0	-	150	Asph							
		150	-	350	Br Cr Gran	150	-	350	3.4			Unacceptable OPSS 1010 Granular A (most sieve sizes too fine)
		350	-	900	Br Sa Tr Gr Tr SI, Moist							
		900	-	1.5	Dk Br Si Sa W Cl Tr Gr, Moist							
Location		5.6 m Lt of C/L, WBL										
BH-P15	3+450	0	-	260	Asph							
		260	-	480	Br Cr Gran							
		480		1.0	Lt Br Gr(y) Sa Tr Si, Moist							
		1.0	-	1.5	Br Si Cl Tr Sa, Moist							

Location		7.8 m Lt of C/L, WB Shld											
BH-P16	3+450	0	-	165	Asph								
		165	-	380	Br Cr Gran								
		380	-	1.5	Lt Br Gr(y) Sa Tr Si, Moist	600	-	900	2.6				Unacceptable OPSS 1010 Granular B Type I (due to excessive fines)
Location		15.0 m Lt of C/L, WB Ditch											
BH-P17	3+450	0	-	200	Dk Br Tps								
		200	-	1.5	Lt Br F Sa So Si Tr Gr, Moist	500	-	800	11.7	0.2	LSFH		
Location		4.0 m Rt of C/L, EBL											
BH-P18	3+700	0	-	200	Asph								
		200	-	450	Br Cr Gran	200	-	450	8.2				Unacceptable OPSS 1010 Granular A (most sieve sizes too fine)
		450	-	850	Lt Br Gr(y) Sa Tr Si, Moist								
		850	-	1.5	Br F Sa Tr Si, Moist								
Location		6.1 m Rt of C/L, EB Shld											
BH-P19	3+700	0	-	180	Asph								
		180	-	450	Br Cr Gran								
		450	-	850	Lt Br Gr(y) Sa Tr Si, Moist								
		850	-	1.5	Br F Sa Tr Si, Moist								
Location		11.5 m Rt of C/L, EB Ditch											
BH-P20	3+700	0	-	100	Dk Br Tps								
		100	-	300	Br F Sa Tr Si, Moist								
			-	300	NFP Rip Rap								
Location		4.5 m Lt of C/L, WBL											
BH-P21	3+950	0	-	160	Asph								
		160	-	460	Br Cr Gran								
		460	-	950	Lt Br Gr(y) Sa Tr Si, Moist	600	-	900	2.1				Unacceptable OPSS 1010 Granular B Type I (due to excessive fines)
		950	-	1.5	Br F Sa Tr Si, Moist								
Location		7.3 m Lt of C/L, WB Shld											
BH-P22	3+950	0	-	160	Asph								
		160	-	470	Br Cr Gran								
		470	-	850	Lt Br Gr(y) Sa Tr Si, Moist								
		850	-	1.5	Br F Sa Tr Si, Moist								
Location		12.5 m Lt of C/L, WB Ditch											
BH-P23	3+950	0	-	180	Dk Br Tps								
		180	-	1.5	Br F Sa Tr Si, Moist								
Location		4.6 m Lt of C/L, WBL											
BH-P24	4+300	0	-	155	Asph								
		155	-	430	Br Cr Gran								
		430	-	840	Br-Gry Sa W Gr Tr Si, Moist								
		840	-	1.5	Br Si Sa, Moist								
Location		7.7 m Lt of C/L, WB Shld											
BH-P25	4+300	0	-	160	Asph								
		160	-	380	Br Cr Gran	160	-	380	10.1				Unacceptable OPSS 1010 Granular A (most sieve sizes too fine)
		380	-	840	Br-Gry Sa W Gr Tr Si, Moist								
		840	-	1.5	Br Si Sa, Moist								
Location		15.2 m Lt of C/L, WB Ditch											
BH-P26	4+300	0	-	170	Dk Br Tps								
		170	-	340	Br Cl Si, Moist								
		340	-	1.5	Br Si Sa Tr Gr Tr Cl, Wet	400	-	700	21.4	0.4	LSFH		
Location		4.4 m Rt of C/L, EBL											
BH-P27	4+580	0	-	160	Asph								
		160	-	420	Br Cr Gran								
		420	-	810	Br-Gry Sa W Gr Tr Si, Moist								
		420	-	1.5	Br Si Cl Tr Sa Tr Gr, Moist								
Location		6.4 m Rt of C/L, EBL											
BH-P28	4+580	0	-	165	Asph								
		165	-	450	Br Cr Gran								
		450	-	800	Br-Gry Sa W Gr Tr Si, Moist	500	-	800	3.7				Unacceptable OPSS 1010 Granular B Type I (due to excessive fines)
		800	-	1.5	Br Si Cl Tr Sa Tr Gr, Moist								
Location		14.0 m Rt of C/L, EB Ditch											
BH-P29	4+580	0	-	160	Dk Br Tps								
		160		400	Br Si Sa, Wet								
		400		1.5	Gry Cl Si, W Sa Tr Gr, Moist								

TABLE 1
RECORD OF BOREHOLE LOGS
Pavement Investigation

Location													
BH-P30	4+735	5.2 m Lt of C/L, WBL											
		0	-	210	Asph								
		210	-	450	Br Cr Gran	310	-	450	8.1			Unacceptable OPSS 1010 Granular A (most sieve sizes too fine)	
		450	-	860	Br-Gry Sa W Gr Tr Si, Moist								
		860	-	1.5	Br Si Cl Tr Sa Tr Gr, Moist								
BH-P31	4+735	7.6 m Lt of C/L, WB Shld											
		0	-	200	Asph								
		200	-	440	Br Cr Gran								
		440	-	950	Br-Gry Sa W Gr Tr Si, Moist								
		950	-	1.5	Br Si Cl Tr Sa Tr Gr, Moist								
BH-P32	4+735	12.5 m Lt of C/L, WB Ditch											
		0	-	140	Dk Br Tps								
		140	-	300	Br Si Sa W Cl, Moist								
		300	-	1.5	Br F Sa Tr Si, Moist								
BH-P33	4+950	4.3 m Rt of C/L, EBL											
		0	-	160	Asph								
		160	-	400	Br Cr Gran								
		400		980	Br-Gry Sa W Gr Tr Si, Moist	600	-	900	3.1			Unacceptable OPSS 1010 Granular B Type I (due to excessive fines)	
		980	-	1.5	Br Si Cl Tr Sa, Moist								
BH-P34	4+950	6.3 m Rt of C/L, EB Shld											
		0	-	160	Asph								
		160		400	Br Cr Gran								
		400	-	960	Br-Gry Sa W Gr Tr Si, Moist								
		960	-	1.5	Br Si Cl Tr Sa Tr Gr, Moist								
BH-P35	4+950	12.3 m Rt of C/L, WB Ditch											
		0	-	140	Dk Br Tps								
		140		1.5	Br Si Cl W Sa, Moist								
BH-36	5+290	5.6 m Lt of C/L, WB L2											
		0	-	180	Asph							Core Only Due to Utility Conflict	
BH-P37	5+290	7.7 m Lt of C/L, WB Shld											
		0	-	170	Asph							Core Only Due to Utility Conflict	
BH-P38	5+290	12.4 m Lt of C/L, WB Ditch											
		0	-	50	Dk Br Tps								
		50	-	1.5	Br Si Cl So Sa Tr Gr, Moist	300	-	600	14.7	0.45	LSFH	CL (LL=25, PL=15, PI=10)	

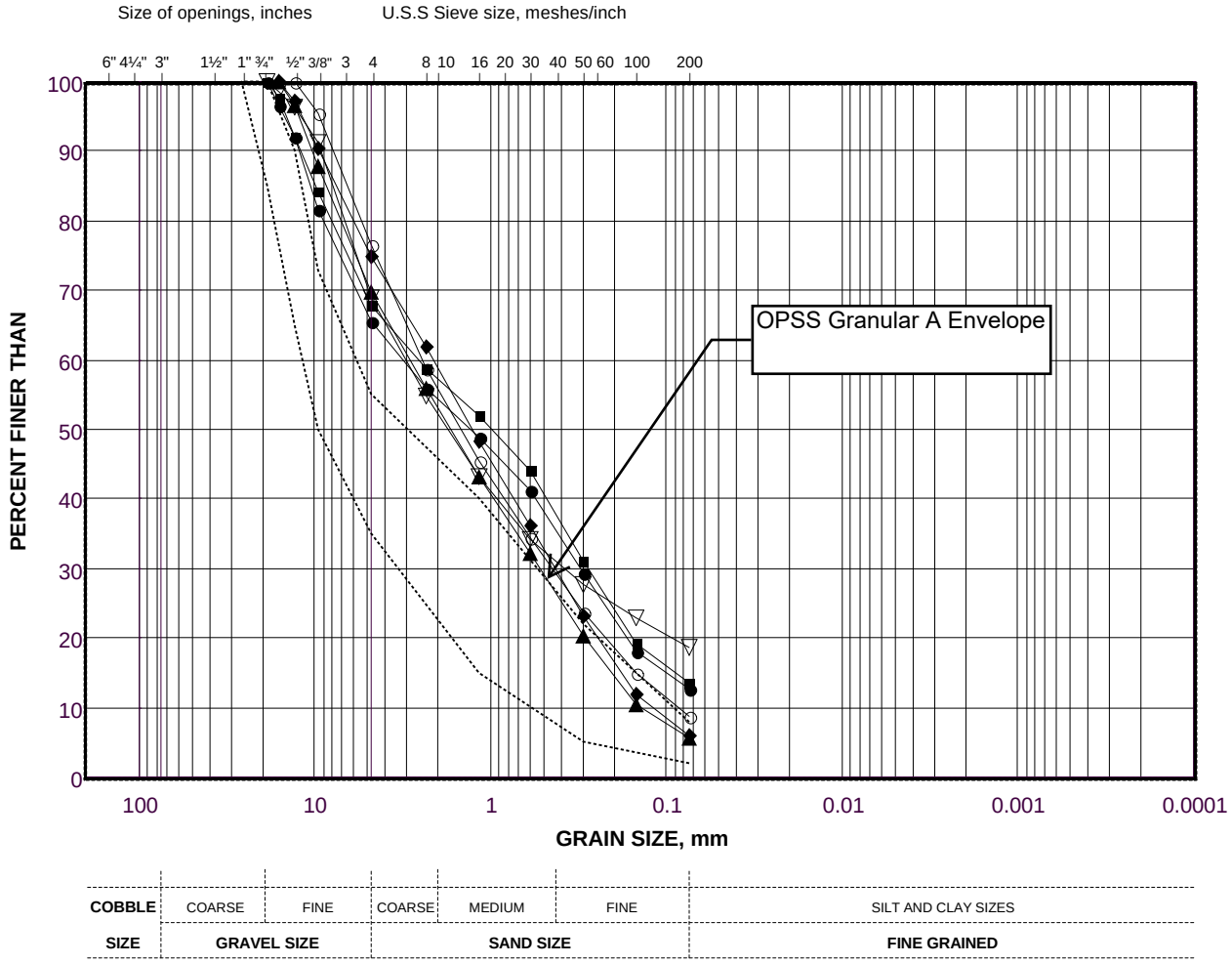
APPENDIX C

Laboratory Testing Results

GRAIN SIZE DISTRIBUTION

Typical Granular Base Material

FIGURE C-1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(mm)
●	P14	1	150 - 350
■	P1	1	300 - 600
◆	P18	1	200 - 450
▲	P25	1	160 - 380
▽	P2	1	200 - 500
❍	P30	1	310 - 450

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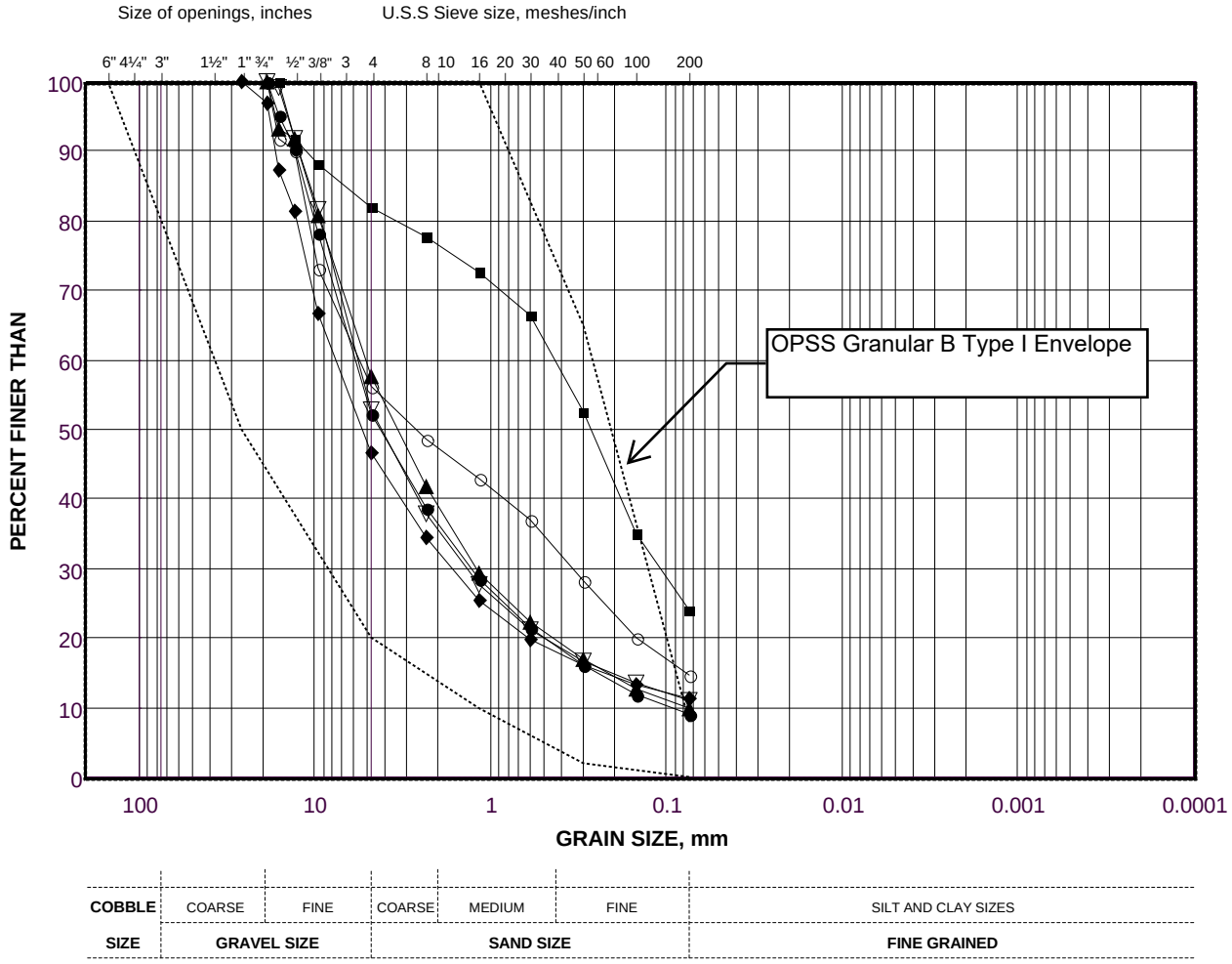
Date: 10-Mar-23

GRAIN SIZE DISTRIBUTION

Typical Granular Subbase Material

FIGURE C-2



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(mm)
●	P21	1	600 - 900
■	P3	1	650 - 950
◆	P33	1	600 - 900
▲	P16	1	600 - 900
▽	P28	1	500 - 800
❍	P8	2	470 - 770

Project Number: 21496759

Checked By: _____

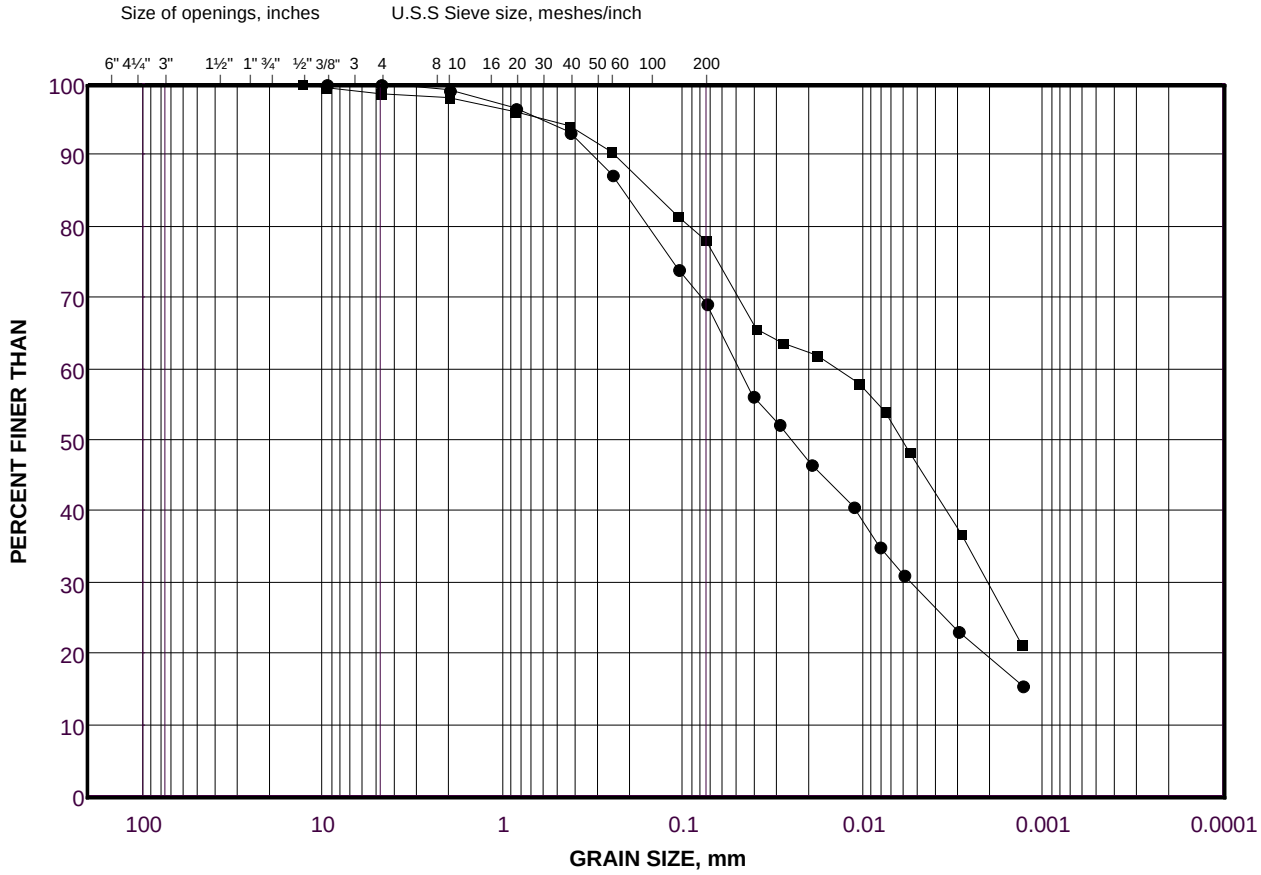
WSP Canada Inc.

Date: 10-Mar-23

GRAIN SIZE DISTRIBUTION

Silty Clay to Clayey Silt Subgrade

FIGURE C-3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(mm)
●	P5	1	1,200 - 1,500
■	P38	1	300 - 600

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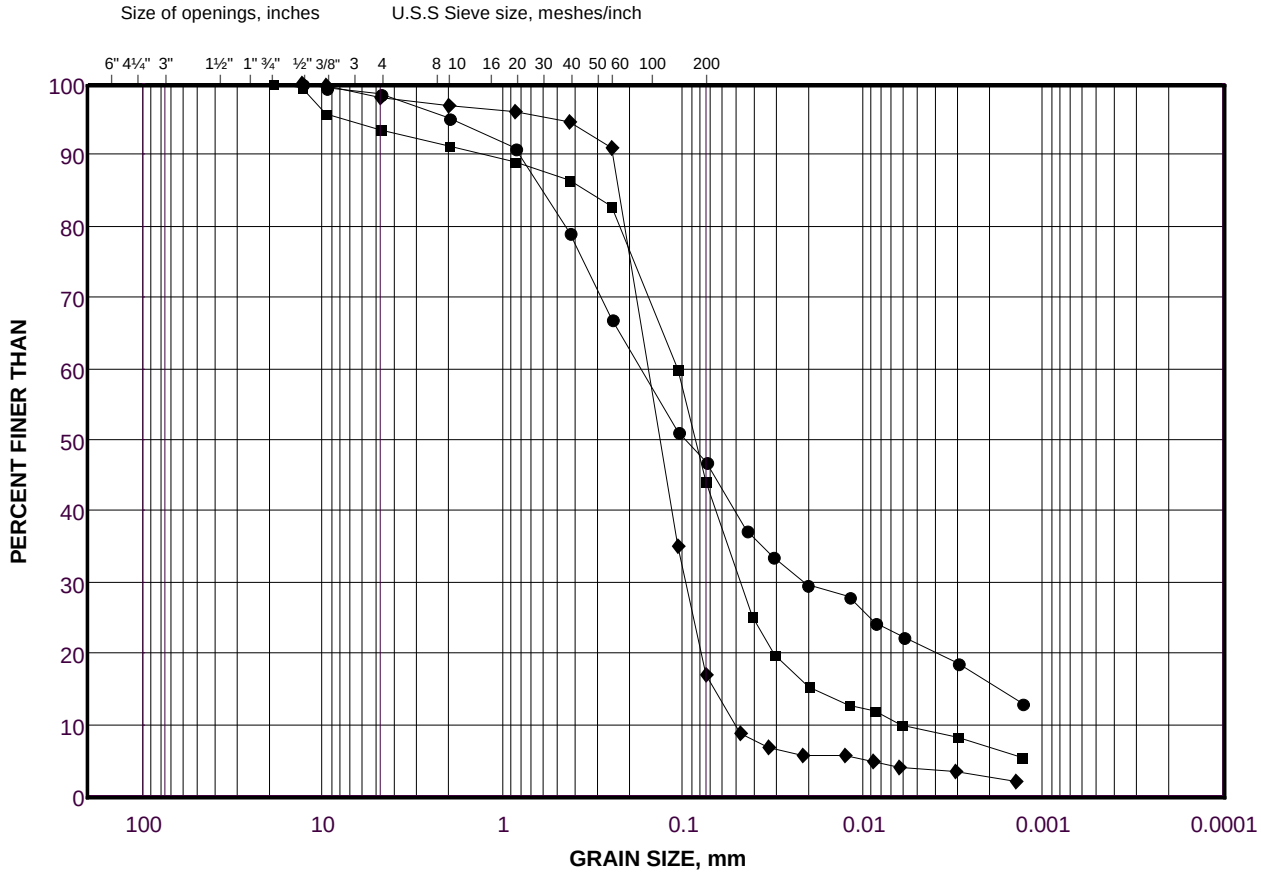
GRAIN SIZE DISTRIBUTION

Silty Sand to Sand Subgrade

FIGURE C-4



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(mm)
●	P10	1	300 - 600
■	P26	1	400 - 700
◆	P17	1	500 - 800

Project Number: 21496759

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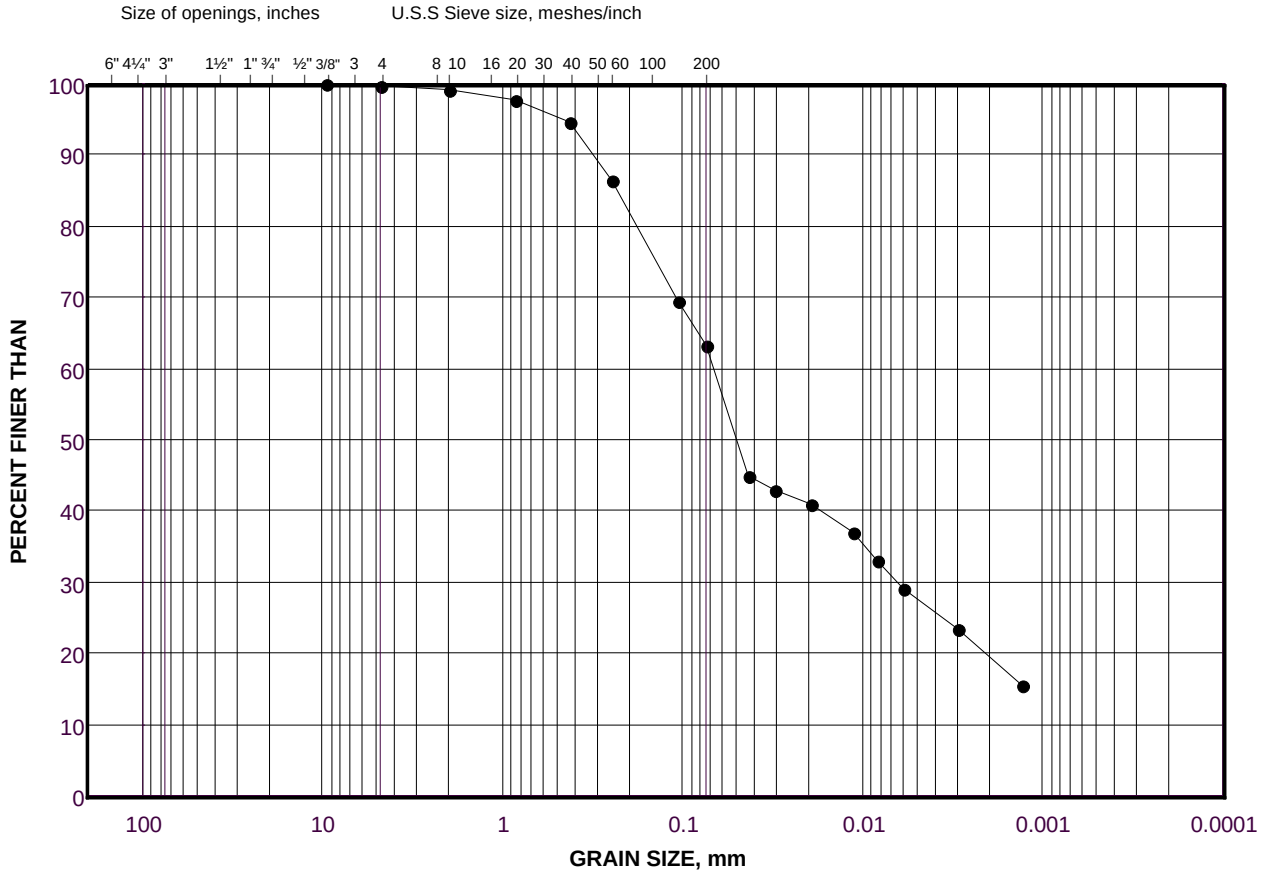
Date: 10-Mar-23

GRAIN SIZE DISTRIBUTION

Sandy Silt Subgrade

FIGURE C-5



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(mm)
●	P12	1	700 - 1,000

Project Number: 21496759

Checked By: _____

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Date: 10-Mar-23

APPENDIX D

ESAL and AASHTO Design Sheets

Table D1
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Teston Road
Keele Street to Dufferin Street
20 Year ESAL Calculation for Realignment New Construction

1) Traffic Analysis

Traffic Data Year		2041		2051	2061
Design Year		**2041**			
Traffic Analysis Period			10	10	
Average Annual Daily Traffic (AADT)		27,790		34,545	42,943
Average Rate of Increase in Traffic (%)			2.20	2.20	
Truck Fraction of Total Traffic (%)		6		6	6
Average Rate of Increase in Truck Fraction (%)			0.00	0.00	
Number of Lanes in One Direction		2		2	2
Directional Factor		0.56		0.56	0.56
Lane Distribution Factor		0.8		0.8	0.8
Daily Truck Volume		**747**		**929**	**929**

2) Daily ESALs Analysis

Road Classification		***Rural Minor Arterial***		
Traffic Analysis Base Year		2041	2051	2061
Breakdown of Truck Proportions (%)	Class 1	45		
	Class 2	5		
	Class 3	35		
	Class 4	15		
Daily Truck Volumes for 4 Classes	Class 1	336	418	418
	Class 2	37	46	46
	Class 3	261	325	325
	Class 4	112	139	139
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.725**	
Daily ESALs per Truck Class	Class 1	168	209	209
	Class 2	86	107	107
	Class 3	418	520	520
	Class 4	616	766	766
Total Daily ESALs in Design Lane		**1,289**	**1,602**	**1,602**

3) Total ESALs for Base Year

Base Year	2041	2051	2061
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**470,327**	**584,659**	**584,659**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**20**	
Span of Design Periods	13.5	2051 to 2061
Average Rate of Increase in Truck Volume (%)	2.20	0.00
Years of Design Periods	10	10
Growth Factor	11.05	11.05
ESALs for the Design Periods	5,197,000	6,461,000
Cumulative ESALs for the Design Period	**11,657,912**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Table D2
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Teston Road
Keele Street to Dufferin Street
20 Year Pavement Design

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	11,700,000
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level (%)	95
Overall Standard Deviation	0.47
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	155

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	180	180	76
2	New Granular A Base	0.14	1.00	200	200	28
3	New Granular B,Type I	0.09	1.00	600	600	54
Total	-	-	-	980	980	158

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00		-	2,750,000	190	80
2	New Granular A Base	0.14	1.00	-	-	220,000	159	22
3	New Granular B,Type I	0.09	1.00	-	-	110,000	585	53
Total	-	-	-	-	-	-	934	155

-

Designed by: KK
Checked by: _____

Table D3
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Teston Road
Dufferin Street to Bathurst Street
15 Year ESAL Calculation for Rehabilitation Design

1) Traffic Analysis

Traffic Data Year		2041		2051	2061
Design Year		**2041**			
Traffic Analysis Period			10	10	
Average Annual Daily Traffic (AADT)		23,350		29,027	36,083
Average Rate of Increase in Traffic (%)			2.20	2.20	
Truck Fraction of Total Traffic (%)		6		6	6
Average Rate of Increase in Truck Fraction (%)			0.00	0.00	
Number of Lanes in One Direction		2		2	2
Directional Factor		0.56		0.56	0.56
Lane Distribution Factor		0.8		0.8	0.8
Daily Truck Volume		**628**		**780**	**780**

2) Daily ESALs Analysis

Road Classification		***Rural Minor Arterial***		
Traffic Analysis Base Year		2041	2051	2061
Breakdown of Truck Proportions (%)	Class 1	45		
	Class 2	5		
	Class 3	35		
	Class 4	15		
Daily Truck Volumes for 4 Classes	Class 1	282	351	351
	Class 2	31	39	39
	Class 3	220	273	273
	Class 4	94	117	117
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.725**	
Daily ESALs per Truck Class	Class 1	141	176	176
	Class 2	72	90	90
	Class 3	351	437	437
	Class 4	518	644	644
Total Daily ESALs in Design Lane		**1,083**	**1,346**	**1,346**

3) Total ESALs for Base Year

	2041	2051	2061
Base Year			
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**395,183**	**491,254**	**491,254**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**15**	
Span of Design Periods	13.5	2051 to 2056
Average Rate of Increase in Truck Volume (%)	2.20	0.00
Years of Design Periods	10	5
Growth Factor	11.05	5.22
ESALs for the Design Periods	4,367,000	2,567,000
Cumulative ESALs for the Design Period	**6,933,667**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Table D4
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Teston Road
Dufferin Street to Bathurst Street
20 Year ESAL Calculation for Widening Design

1) Traffic Analysis

Traffic Data Year		2041		2051	2061
Design Year		**2041**			
Traffic Analysis Period			10	10	
Average Annual Daily Traffic (AADT)		23,350		29,027	36,083
Average Rate of Increase in Traffic (%)			2.20	2.20	
Truck Fraction of Total Traffic (%)		6		6	6
Average Rate of Increase in Truck Fraction (%)			0.00	0.00	
Number of Lanes in One Direction		2		2	2
Directional Factor		0.56		0.56	0.56
Lane Distribution Factor		0.8		0.8	0.8
Daily Truck Volume		**628**		**780**	**780**

2) Daily ESALs Analysis

Road Classification		***Rural Minor Arterial***		
Traffic Analysis Base Year		2041	2051	2061
Breakdown of Truck Proportions (%)	Class 1	45		
	Class 2	5		
	Class 3	35		
	Class 4	15		
Daily Truck Volumes for 4 Classes	Class 1	282	351	351
	Class 2	31	39	39
	Class 3	220	273	273
	Class 4	94	117	117
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.725**	
Daily ESALs per Truck Class	Class 1	141	176	176
	Class 2	72	90	90
	Class 3	351	437	437
	Class 4	518	644	644
Total Daily ESALs in Design Lane		**1,083**	**1,346**	**1,346**

3) Total ESALs for Base Year

Base Year	2041	2051	2061
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**395,183**	**491,254**	**491,254**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**20**	
Span of Design Periods	13.5	2051 to 2061
Average Rate of Increase in Truck Volume (%)	2.20	0.00
Years of Design Periods	10	10
Growth Factor	11.05	11.05
ESALs for the Design Periods	4,367,000	5,429,000
Cumulative ESALs for the Design Period	**9,795,457**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Table D5
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Teston Road
Dufferin Street to Bathurst Street
15 Year Rehabilitation Design

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	7,000,000
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level (%)	90
Overall Standard Deviation	0.47
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	137

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	150	150	63
2	Existing Hot Mix Asphalt	0.28	1.00	75	75	21
3	Existing Granular Base	0.12	0.80	260	260	25
4	Existing Granuar Subbase	0.09	0.80	440	440	32
Total	-	-	-	925	925	141

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00		-	2,750,000	58	24
2	Existing Hot Mix Asphalt	0.28	1.00		-	2,750,000	170	48
3	Existing Granular Base	0.12	0.80		-	200,000	196	19
4	Existing Granuar Subbase	0.09	0.80		-	105,000	650	47
Total	-	-	-	-	-	-	1074	138

-

Table D6
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Teston Road
Dufferin Street to Bathurst Street
20 Year Widening Design

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	9,800,000
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level (%)	95
Overall Standard Deviation	0.47
Roadbed Soil Resilient Modulus	25,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	160

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	180	180	76
2	New Granular A Base	0.14	1.00	250	250	35
3	New Granular B,Type I	0.09	1.00	550	550	50
Total	-	-	-	980	980	161

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00		-	2,750,000	185	78
2	New Granular A Base	0.14	1.00	-	-	220,000	155	22
3	New Granular B,Type I	0.09	1.00	-	-	110,000	669	60
Total	-	-	-	-	-	-	1010	160

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